

CAMBIUM PTP 500 AND PTP 600 TECHNOLOGIES
BEST-IN-CLASS
WIRELESS PERFORMANCE



UNIQUE FUNCTIONALITY FOR BETTER CONNECTIVITY

Cambium Point-to-Point (PTP) 500 and PTP 600 Series solutions employ a unique combination of technologies that offers up to 99.999% availability in highly challenging environments and extreme weather conditions. In communication paths with challenges such as high interference, obstructions, water, long-distance hops, and brutal weather events, our PTP 500 and 600 systems are often the only systems that can connect reliably. Such performance excellence is unique in the wireless broadband world where 95% availability or “good enough” is often the norm.

PTP 500 AND 600 SERIES SOLUTIONS

Our PTP 500 and 600 radios are high-throughput, secure, carrier-class solutions that are cost-effective, quick to deploy, and easy to manage. This family of products includes models that operate in the 2.5, 4.5, 4.8, 4.9, 5.4, and 5.8 GHz radio frequencies. So, you have great choice and flexibility to meet your individual regulatory, application, and environmental requirements. Operating at Ethernet data rates up to 300 Mbps, the systems can support a wide variety of demanding applications, including:

- T1/E1 leased-line replacement and extensions
- Video surveillance connectivity and backhaul
- Backhaul for point-to-multipoint and LTE networks
- Rapid deployment for disaster recovery, emergencies and special events
- Added capacity for backbone operations
- Network redundancy and extensions
- Building-to-building and campus connectivity
- Battlefield communications
- Telemetry and LMR backhaul
- Migration to an all-IP network

AWARD-WINNING TECHNOLOGY

PTP 500 and 600 Series solutions work where other systems often cannot even make a connection. This performance excellence is achieved through a powerful combination of award-winning technologies that enable our radios to overcome the key factors that degrade

all radio signals, including signal attenuation, fading, dispersion, and polarization. First, we add intelligence to proven technologies like Orthogonal Frequency Division Multiplexing (OFDM), Adaptive Modulation, and Dynamic Frequency Selection. Then we optimize the individual technologies to work at maximum efficiency with our systems.

Every effort has been made to ensure that our radios can achieve the highest possible throughput for the given interference conditions. As an example, our preamble-free communications maximize your throughput by eliminating the time overhead required during transmissions. Such breakthrough engineering delivers the high level of capacity, signal quality, spectral efficiency, and performance that our customers have come to expect from our radios.

MULTIPLE-INPUT MULTIPLE-OUTPUT (MIMO)

Non-line-of-sight (NLOS) and other challenging environments create all kinds of signal distortion issues. Connections are subject to massive periodic fading, often dropping to 1/10,000th of the already highly attenuated level. Because there is no main path and just many indirect paths of similar energy, signals are prone to be out-of-phase. This dramatically raises the risk that signals will cancel each other.

With PTP-optimized MIMO technology, several data streams are transmitted between multiple transmitters and receivers. At the receiving end, all the data streams are compared and evaluated until the data image is accurately restored and sequenced. This significantly reduces fading and radically increases the probability that the receiver will decode a usable signal, giving you consistently reliable, high-performance communications in even the toughest environments.



Cambium's MIMO implementation minimizes signal fading due to path obstructions or atmospheric disturbances.

PTP-OPTIMIZED TECHNOLOGIES CONQUER CHALLENGES

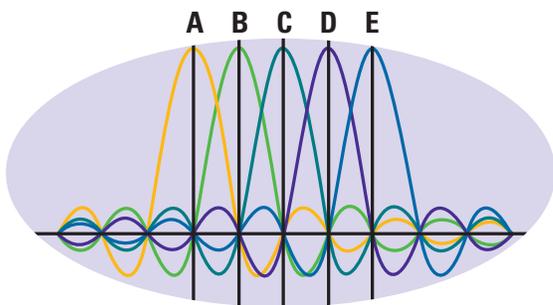
INTELLIGENT-OFDM

In challenging path conditions, signals arrive by many different (dispersed) paths. Because path lengths vary, the signals also arrive at different times. In addition, the paths have different delay characteristics, causing previously transmitted data bits to interfere with current data bits. This interference is known as multipath inter-symbol-interference or ISI.

Conventional radios resolve the problem using an ISI equalizer. Comparable NLOS systems employ some form of OFDM (Orthogonal Frequency Division Multiplexing) to overcome this problem, but none of them adds the intelligence that is embedded in Cambium's intelligent OFDM (*i*-OFDM).

Standard OFDM separates data into channels which overlap in frequency. Orthogonal to each other, the channels do not interfere with each other, resulting in better spectrum efficiency and higher data throughput. OFDM allows the radios to compensate for environmental conditions by applying a uniform phase correction to all channels simultaneously – a correction value that can be modified on the fly in response to external events. Our *i*-OFDM not only resolves channel dispersion, achieves high spectral efficiency, and offers high resistance to frequency-selective fading, but it also offers the following enhancements not available in other OFDM products:

- Significantly more pilot tones and sub-carriers
- Instant fade recovery



OFDM transmits data on multiple frequencies, resulting in greater resistance to interference and signal fading.

ADVANCED SPECTRUM MANAGEMENT WITH *i*-DFS

Channel frequencies can be set either manually or dynamically. When configured as dynamic, PTP 500 and 600 radios will automatically change channels to avoid interference and combat link fading without dropping the

link. At power-up and throughout operation, PTP 500 radios sample the band up to 400 times a second, while PTP 600 radios sample the band up to 1,200 times a second. Both radios dynamically select the frequency over which they can sustain the highest data rate at the best quality. This means that your radios are very likely to find a clear channel (without operator intervention) even in a crowded space.

The 30-day, time-stamped database alerts you to any interference that exists and provides statistics that help you pinpoint the channels that provide the clearest data paths. In day-to-day operation, these spectrum management capabilities can provide you the same benefits as having exclusive rights to a licensed channel.



Cambium's *i*-DFS self-selects the frequency over which it can sustain the highest data rate at the highest availability.

In addition to *Intelligent* Dynamic Frequency Selection (*i*-DFS), our unique spectrum management features include two other techniques:

- Fixed frequency – You can preset (lock in) link frequency so that it stays within the best channel known to be available
- Channel tuning – You can adjust the center of the channel up or down to optimally fit it into the available spectrum

ADAPTIVE MODULATION

Adaptive Modulation maximizes throughput by continually optimizing signals according to your specific radio path conditions. This enables your transmissions to travel from one receiver to the next without signal loss. The radio's modulation mode is dynamically modified according to the received signal level, upshifting or downshifting to overcome fading. Since the channel may vary in intensity on a sub-second basis, adapting the modulation dynamically allows the maximum amount of data possible to be sent across the path while keeping the link quality at the highest level.

Available modulation modes include 256, 64, and 16 QAM, plus, QPSK, BPSK, all with multiple FEC rates, and single and dual payload.

IMPROVED CAPACITY AND SPECTRAL EFFICIENCY

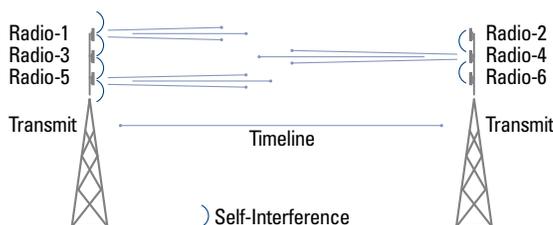
SAMPLE MODULATION AND DATA RATES FOR PTP 600 SYSTEMS

Modulation Mode	30 MHz Channel			10 MHz Channel		
	Tx	Rx	Both	Tx	Rx	Both
256 QAM 0.81 Dual	150.01	105.01	300.02	49.14	49.14	98.29
256 QAM 0.81 Single	75.00	75.00	150.01	24.57	24.57	49.14
64 QAM 0.75 Dual	103.28	103.28	206.57	33.84	33.84	67.67
64 QAM 0.75 Single	51.64	51.64	103.28	16.92	16.92	33.83
16 QAM 0.87 Dual	80.35	80.35	160.70	26.32	26.32	52.64
16 QAM 0.87 Single	40.17	40.17	80.35	13.16	13.16	26.32
QPSK 0.87 Single	20.09	20.09	40.17	6.58	6.58	13.16
BPSK 0.63 Single	7.22	7.22	14.44	2.36	2.36	4.73

TIME DIVISION DUPLEXING (TDD) SYNCHRONIZATION

In deployments where a number of radios are installed on the same tower or rooftop or where a large number of links are installed in a sizeable, dense network configuration, it is very possible that the performance or throughput of some of the links can be reduced. This reduction in performance is caused by cross interference between the collocated radios. Cross interference occurs when transmit and receive frames are unsynchronized, meaning that some radios are transmitting while their neighbors are receiving. Our innovative interface design makes our PTP 500 and 600 radios more tolerant of cross interference.

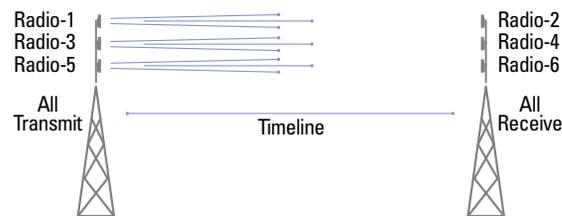
As an example, if Radio-1 and Radio-5 are transmitting when radio-3 is receiving, radio-4's incoming transmission can be interfered with even if the transmissions are on different frequency channels. Because the signals from Radio-1 and Radio-5 are so close, they are strong enough to "flood" or interfere with the communications flowing to radio-3.



Unsynchronized TDD with Significant Cross Interference.

To reduce this cross interference, it is important that all radios on the tower or rooftop transmit at the same time and receive at the same time. With PTP 500 and 600 Series

bridges, our TDD Synchronization capability times and synchronizes transmit and receive signals, enabling efficient frequency reuse. This allows you to collocate multiple radios on a rooftop or tower while greatly reducing the interference.



Synchronized TDD with Greatly Reduced Cross Interference

PTP 500 and 600 radios include TDD synchronization technology which introduces a fixed TDD framing mode and allows frame timing to be synchronized with other PTP 500 and 600 radios or an external Global Positioning System (GPS) timing module. In addition, wayside T1/E1 transport is tightly integrated with our TDD structure, offering exceptionally low jitter and wander over our radios.

Our PTP-SYNC unit offers a reliable and convenient timing reference for PTP 500 and 600 radios. The PTP-SYNC receives a time signal from a clock source, sends the signal to the PTP radio, and maintains synchronization between collocated radios when timing is unavailable, as can occur if a satellite goes off-line for a period of time. When a PTP 500 or 600 radio receives the PTP-SYNC's timing reference signal, it adjusts its own timing until precise synchronization is achieved.

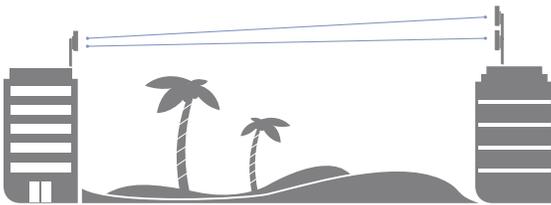
EXCEPTIONALLY LOW JITTER AND WANDER

SPATIAL DIVERSITY

The PTP 500 and 600 systems include spatial diversity to combat ducting and multipath fading. Spatially diverse technology allows communications to travel over water, across vast expanses of open terrain, and in deep non-line-of-sight environments without signal loss.

As radio waves travel across distances, especially over water and flat terrain, they run an increased risk of multipath interference caused by signals reflecting off the water, desert or flat plain. This interference can cause the signals to cancel each other as they travel to the receiver from various directions over multiple paths. In addition, signals can experience ducting as they move through air masses of different densities, which deflect the signals away from the receiving antenna, often cutting communication between radios.

In these situations, spatially diverse antennas, or vertically separated antennas, can be deployed at one or both ends of the link. The spatially diverse antennas transmit over two radio paths to the receiver, so that the paths do not experience reflection and ducting at the same time. By optimally combining the separate transmissions, our PTP 500 and 600 radios can eliminate signal cancellation and maximize the signal received in each direction.



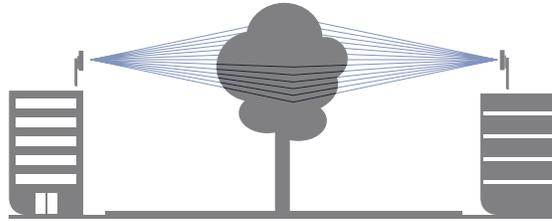
Spatial diversity combats ducting and multipath fading via vertically-separated antennas at one or both ends of a link.

BEST-IN-CLASS RADIOS

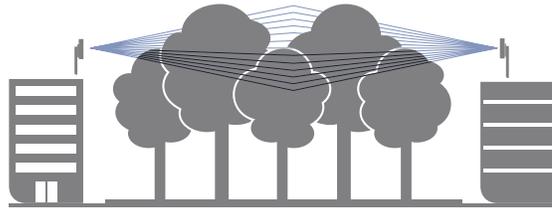
Signal attenuation occurs when natural or man-made obstacles in the path reduce the radio signal. Typical NLOS and other challenging environments can reduce a signal to 1/10,000th of a normal LOS signal, because the signals are forced to arrive by diffraction around an object or reflection off objects that surround the obstruction, or by penetrating the obstruction – all of which substantially weaken the signal.

Our best-in-class radios maximize the system gain to effectively overcome attenuation. By pairing high-output transmitters with ultra-sensitive receivers, the radios can

achieve a best-in-class system gain of up to 169 dB using 22 dBi integrated antennas. Higher system gain allows your communications to go farther and faster. So, you can reduce the number of hops and the associated equipment, tower, installation, and operational costs while achieving higher reliability and performance than is feasible with most comparable systems.



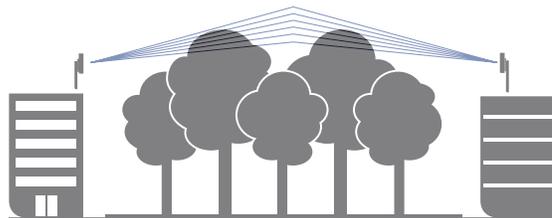
20 dB
1/100th



30 dB
1/1,000th



30 – 40 dB
1/1,000th to
1/10,000th



40 dB
1/10,000th

Our PTP 500 and 600 radios maximize system gain and, therefore, the speed and range of the communications.

With a dedicated logic-based data path built into our circuitry, PTP 500 and 600 communications do not have to go through a general-purpose central processing unit (CPU) or data service unit (DSU). The result is that latency and jitter are greatly reduced, and data throughput is not limited by packet-processing capability as in many comparable products.

ROBUST SECURITY AND INDUSTRY CERTIFICATIONS

INFORMATION ASSURANCE

Recognizing the importance of securing your wireless communications, we have invested and continue to invest significant amounts of time and budget to protect your PTP communications. The following robust security features are available on PTP 500 and 600 systems:

- 128-bit and 256-bit AES encryption
- FIPS 140-2 validation for cryptographic algorithms, key security and tamper evidence (PTP 600)
- HTTPS/TLS and SNMP v3 for management interface protection
- Identity-based user accounts with configurable password rules
- Remote Authentication Dial-In User Service (RADIUS) to remotely authenticate users and their levels of access based on your individual network policies
- Logging of security and other events and syslog support
- Configuration-file “save and restore” feature, allowing you to quickly restore the file if a unit needs to be reset or replaced
- Vulnerability management and resolution

PRODUCT VALIDATIONS AND CERTIFICATIONS

PTP 500 and 600 solutions have obtained a number of certifications that comply with key industry performance and durability standards.

- **UC APL:** PTP 600 solutions are listed on the Department of Defense (DoD) UC APL (Unified Capabilities, Approved Products List), indicating that the systems comply with requirements for interoperability and information assurance.
- **ATEX and HAZLOC Certification:** PTP 600 radios comply with ATEX (ATmospheres EXplosibles) and HAZLOC (Hazardous Locations) directives for equipment operations in hazardous locations. Typical locations which require these certifications include petrochemical plants, fixed offshore platforms, and other areas where a potentially explosive atmosphere may be present.
- **IP 66 and 67 Ratings:** The IP Code, or Ingress Protection Rating, classifies the degrees of protection provided against the intrusion of solid objects, dust and water in electrical enclosures. PTP 600 ODUs with aluminum casings are IP 66 rated against dust and water intrusion as a result of testing with dust and powerful water jets aimed at the enclosure from any direction. In addition, PTP 600 ODUs are IP 67 rated for protection against the effects of water intrusion as a result of being immersed in water.
- **MEF9 Certified:** PTP 500 and 600 systems are tested and MEF9 (Metro Ethernet Forum) certified as compliant with the MEF’s essential specifications. So, you can be confident that your PTP 500 or 600 solution will operate with your existing MEF9-compliant network equipment.

For more information on our PTP solutions, refer to the [PTP 500](#) and [PTP 600](#) Series brochures and specification sheets.



www.cambiumnetworks.com